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SURVEYOR

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Fuel of the Future,
Finally

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Great Cyber Chess Game 6

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POSIDONIA
SPECIAL
ISSUE



OUR DIGITAL FUTURE

We continue refining marine structures to make them safer and stronger. More and more these analyses are conducted with digital methods. Going forward our efforts will focus on digital technologies, leveraging data streams to refine design, inform class, optimize maintenance and improve performance. Managing data quality and ensuring cyber security are key fundamentals to getting the greatest value from advanced data analytics, machine learning and artificial intelligence. This new frontier will change our industry in ways we currently cannot fathom – and is an exciting adventure that we will embrace together to continue to increase efficiencies and reduce our environmental impact.

COVER

Greece is a maritime nation by tradition, with a rich history in the shipping industry. Shipping continues as the most significant industry in the Greek economy. The Hellenic Merchant Marine boasts the world's largest merchant fleet in terms of tonnage which includes over 5,000 vessels engaged in commerce and transportation of goods and services across the globe. The Greek shipping industry works closely with marine industry stakeholders, universities, equipment manufacturers, ship designers and classification organizations to advance technology that improves efficiency and performance, while reducing environmental impact.



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FUEL OF THE FUTURE, FINALLY

For most of its history, liquefied natural gas (LNG) was rather like the ten-thousand-dollar banknote: limited in circulation, outside normal markets, appreciated by many, but handled only by an exclusive club of users. Today it is quite democratic, used increasingly around the world as an important part of the energy future of many nations – it is so desired and so high-profile, in fact, that one can easily forget how dramatically the world of LNG and its maritime transport has changed in a relatively short timeframe.

In 1993, LNG was sold before it was made, and virtually all the world's production was locked into long-term gas supply contracts held by a handful of power generation entities. LNG shipping originated as the facilitating technology behind those contracts, which typically had durations on the order of 25 years. The global fleet of LNG tankers at the time totaled about 70 vessels. New carriers were under construction for the first time in years, but seven of the latest to enter service had actually been reactivated after a decade in mothballs.

Although not so long ago, those days seem as distant as the time of biplanes and crank-started cars. Today there are some 80 LNG carriers on order alone, and the world fleet expects to see 500 vessels in service by year's end. That immense fleet expansion resulted from a long-awaited global boom in the use of natural gas for power generation, spurred by expansion of existing networks and national green energy initiatives.

Twenty-five years ago, world LNG imports totaled about 60 million tons per year (mt/y); by the beginning of 2018, the figure stood at 293 million tons and growing. In that same period, the number of LNG importers more than quadrupled, from fewer than 10 to more than 40. The advent of floating storage and regasification units (FSRUs) in recent years further accelerated the 'democratization' of LNG by bringing reliable power generation to islands and other locations without a ready gas pipeline infrastructure. The world's first FSRU was time-chartered in 2007, and over the next 11 years was followed into service by nearly 30 more. Small wonder, that looking forward, many analysts expect the global gas chain to become even more diverse and

widespread over the next two decades, with some predicting the number of liquefaction sites worldwide will double by 2040.

LIMITLESS POTENTIAL

Altogether, the world LNG carrier fleet, once rather limited in scope and capacity, has begun to resemble the crude carrier fleet in diversity and size – and cyclicity. The periodic cycle of prosperity, vessel oversupply and freight rate collapse, familiar in the tanker sector, is now a fact of life for LNG carriers as well. Between 2012 and 2015, oversupply helped cause LNG carrier earnings to drop from \$140,000/day to \$20,000/day. However, demand slowly caught up with supply and, by end 2017, modern gas tankers on certain routes were commanding rates of up to \$85,000/day. Despite that grand hiccup, not all reports talking of the 60-plus LNG carriers due for delivery this year are filled with fear and trembling. LNG currently accounts for about 12 percent of the world gas market. According to 2017 figures from the International Gas Union (the latest available as this issue went to press), current world liquefaction capacity stands at 340 mt/y. With 30 mt/y in new production scheduled to come onstream this year, to be followed by a further 33 mt/y commissioned in 2017, global hunger for LNG does not appear set to plateau any time soon.

“I expect continued demand growth for natural gas and LNG as economies need energy and prioritize cleaner forms,” says Mark Ross, President of Chevron Shipping Company. “The associated ongoing growth of demand for LNG shipping, increasingly diverse trade flows and an expanding array of LNG ship designs and technologies means that shipowners will continue to see interesting opportunities in the years ahead – but



**Mark Ross, President of
Chevron Shipping Company**

that will come with a greater number of uncertainties and challenges that need to be managed.”

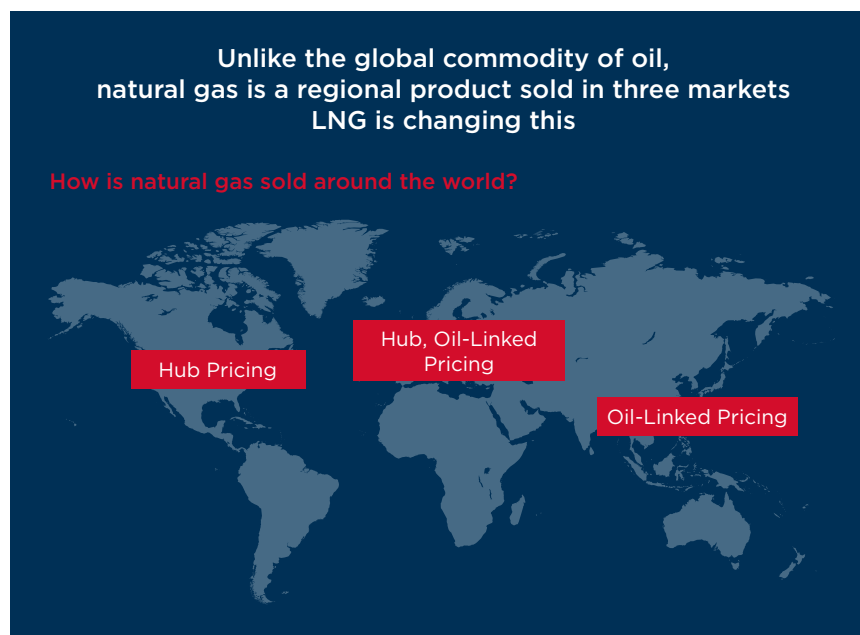
Gas is a clean and desirable fuel, but for many users comes with added costs from its enabling technologies – natural gas may be cheap, but LNG is not. In the absence of an existing pipeline, customers wanting the benefits of natural gas must avail themselves of the LNG network and absorb their share of the costs of liquefaction (chilling it to -162°C), shipping, and then storage and regasification at the delivery point.

Today, amid a growing global commitment to LNG, the market forces that once strongly encouraged long-term, full production contractual commitments to bring liquefaction projects online, are finding new opportunities in more flexible approaches to the business. As of last year, about 30 percent of all LNG contracts were of less than two years duration.

“The cost of liquefaction, sea transportation, storage and delivery via pipeline can be quite significant; not all economies can afford as much LNG as they might like. Because of these expenses, LNG has always required a certain level of commitment to incentivize parties to build the required value chain,” Ross says.

**Unlike the global commodity of oil,
natural gas is a regional product sold in three markets
LNG is changing this**

How is natural gas sold around the world?





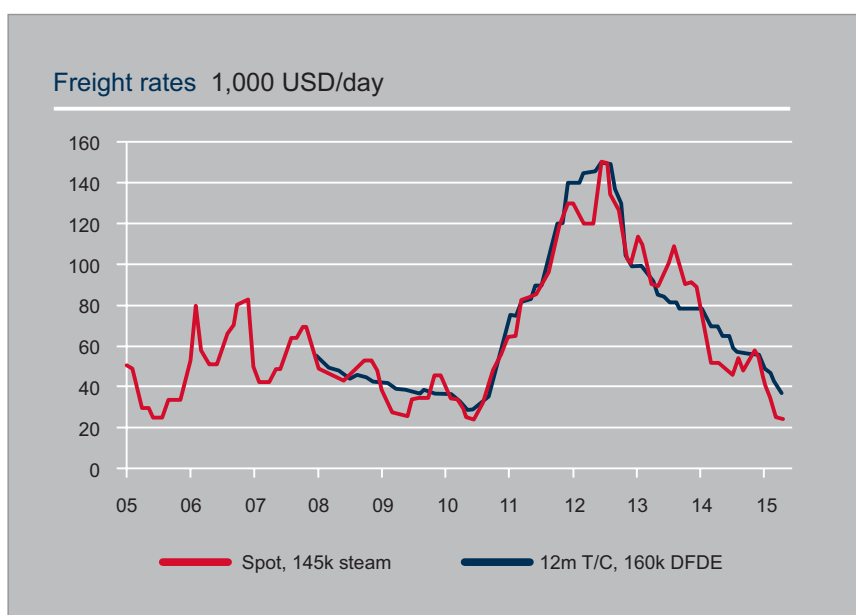
"Recently, we have seen LNG projects approved and constructed without having pre-sold 100 percent of available production," he adds. "The availability of this uncommitted supply has coincided with changes in the demand side of the market, where both traditional and emerging LNG buyers are seeking more flexible contract terms, including a range of durations, to enable them to better manage their own demand uncertainties. Further, the number of LNG projects has grown and more excess or 'upside' LNG production has become available for sale on an opportunistic basis."

LOW PRICE, HIGH PROMISE

"Cheap gas" has long been a key phrase in the evolution of the world's energy mix. But "cheap" is a relative term. A growing number of countries are assigning a real value to environmental stewardship, and their governments are following through with significant commitments to natural gas and alternative energy sources. At the same time, demand for gas has potential to reach immense proportions. Availability of gas through FSRUs is making LNG the gateway to electric power

for remote and underserved people in developing nations, which make up about 85 percent of the world population. One day soon the answer to the question "how cheap is cheap enough" may become more of a value judgment than a straightforward calculation.

Although today's growing number of suppliers and customers has given rise to an active market for spot purchases of LNG, its pricing is inconsistent





and varies widely between regions and even within countries – differences of up to 40 percent have been recorded for purchases made in the same country at the same time. While disconcerting to some, others see stability emerging within that variation. Notable among the believers are those leading the Forward bulk carrier project, which is in the final stages of developing the world's first long-distance LNG-fueled bulk carrier (see page 10). An estimate of future global LNG pricing was critical to their business model for the revolutionary vessel.

"While there will certainly be movement in the price of gas, we expect to see less of a price fluctuation with LNG than with oil," says Antonis Trakakis, Technical Director of Athens-based Arista Shipping, sponsor of the Forward Project. "Worldwide, there is a huge abundance of gas in many countries. This diffusion does not allow the same kinds of games to be played with gas as has been done with oil," he explains. "Of course, anything can happen, but the gas is there," he says, "and the technology, production and abundance – and potential for a stable LNG market to develop – are all in place."

Still, the lack of a global price for LNG and its lower "destination flexibility" as compared with oil give some analysts cause to contend that it is not truly a "global commodity". In the sense that three distinct international markets for it have developed – Europe, Asia and The Americas – as compared to the single

world market for oil, the point is understandable. Up until the start of the unconventional oil & gas revolution about a decade ago, there was an accepted link between the pricing of oil and natural gas, and every resurgence of LNG as "the fuel of the future" over the past 40 years reflected this connection in expectant discussions about the day when LNG would be traded "just like oil." But, with those links now gone, continued comparison between the two is not especially meaningful. The combination of economic, logistic, technological and political forces that affect the LNG business have caused a unique global market for it to arise – even if that marketplace looks more like a souk than a supermarket. In the new world of LNG, in fact, it is possible that consistent worldwide pricing might not be desirable at all.

"From a ship owner's perspective, the important aspect is what tonne-mile demand is associated with the new and growing trade flows," Ross says. "To the extent that a global LNG price evolved at some future point, it might inhibit the longer-haul 'arbitrage' trades that arise from regional price differentials and, thus, be a negative factor for overall shipping demand. It is important for all participants in the LNG value chain that it remains competitive against alternative sources of energy," he adds. "Safe, reliable and efficient LNG transportation plays an important role in ensuring that continues to be the case." ■



FROM THE FRONT LINES:

STAYING AHEAD IN THE GREAT CYBER CHESS GAME

The fact that the vast bulk of cyber crime has not been targeted against ships, or their operating companies, is of little importance in the big picture of maritime cyber security. After all, the bad guys don't need to do much targeting when the good guys open the door and wave a lantern at them from the porch.

To invite the devil into the den takes no more than a compromised device, or flash drive plugged into a system USB port, or a trick e-mail containing a malicious link or a deceptive attachment unfortunately clicked while on a company desktop. Once inside one computer, the demon can spread to any other it contacts. That's what happened last year, when a malicious "update" to a popular Ukrainian accounting program released ransomware that ultimately ended up inside several global organizations including shipping giant Maersk, where it caused some \$300 million worth of trouble and, as collateral damage, interfered with operations in several of the world's major ports.

Speaking at the World Economic Forum in January, Maersk Chairman Jim Hagemann Snabe spoke of the attack and its remedy, which essentially required a reinstall of the company IT infrastructure – some 4,000 servers, 45,000 PCs, and 2,500 applications. He could have been speaking for the wider maritime industry when he said "We were basically average when it came to cyber security, like many companies. This was a wake-up call to not just become good, but to have cyber security as a competitive advantage."

Like Ransomware, botnets and other menaces currently getting great attention in the press, a large part of the overall cyber threat is impersonal in nature and, therefore, unpredictable as to point and time of arrival. Survival in the cyber arena, then, depends largely on vigilance and general preparedness. This is reflected in new requirements from the IMO giving shipowners and managers until 2021 to incorporate cyber risk into their Safety Management Systems, and, of more immediate effect, in the latest version of the Tanker Management Self-Assessment

(TMSA) program from the Oil Companies International Marine Forum (OCIMF).

The new TMSA3 instructions, issued by OCIMF in April 2017, contain a new chapter on Maritime Security that includes extensive onboard and in-office cyber security vetting requirements. Companies must, for example, have a written cyber security plan that addresses procedures to identify, mitigate and respond to threats, and may include the elements of said plan as amendments to the company Safety Management System. TMSA3 also attempts to promote onboard cyber security vigilance by encouraging crewmembers to lock unattended workstations, to use social media responsibly and attentively, and to be very careful regarding flash drives.

Despite those and other good moves, the maritime sector's cyber awakening is proving to be a painfully slow process. In a cyber security article two years ago, we reported on a study co-sponsored by the Liberian Registry that concluded the state of maritime cyber awareness to be dangerously poor. The list of chief vulnerabilities for ships and maritime organizations discovered during that research bears repeating, because it hasn't changed:

- Little to no evidence of cyber security policy
- Little to no cyber awareness among the crew
- Unsupported/obsolete operating systems, even in some new-builds
- Many unpatched systems
- Many systems without anti-virus software or updated anti-virus definitions
- Unauthenticated or bypassed workstation or system access
- Dangerous modifications by crew (to software or systems) and evidence of ad-hoc networking by the crew
- 'Small Office/Home Office' IT infrastructure, inappropriate for an industrial environment
- Removable media access on shipboard PCs
- No cyber auditing occurring as a shipboard and ship management safety procedure
- Internet-connected Industrial Control Systems
- Critical systems connected to the internet without protections or segregation
- Many systems Ethernet-connected and Internet-ready, but not protected.

If these points of concern sound familiar – and especially if they don't – it is quite possibly time for a cyber assessment.



Panos Zachariadis
Technical Manager,
Atlantic Bulk Carriers

INTROSPECTION VITAL TO CYBER HEALTH

What troubles cyber security advocates most is that too many companies and individuals in the maritime world still do not give the Devil his due, so to speak, underestimating their cyber risks and underperforming in their cyber preparedness.

That said, maritime cyber-awareness has made some improvement in the past two years, according to Panos Zachariadis, Technical Manager of Athens, Greece-based Atlantic Bulk Carriers. A Board member of Greece's Marine Technical Managers Association (Martecma) and member of BIMCO's Marine Committee, Zachariadis participated in developing the industry's first cyber security guidelines, published by BIMCO and later adopted by IMO.

"A growing number of companies now understand the seriousness of cyber issues, so if I were to pick a grade for the level of cyber awareness today I would say it is poor, but closing in on fair," Zachariadis says. "Through my work with BIMCO, I had the good fortune to be involved with maritime cybersecurity early on, and to realize personally that it is a critical issue. Until recently, the industry as a whole did not see it that way. Many people thought – and still think – that cyber threats don't apply to us, that it's all overblown by cyber security salesmen trying to scare us into buying an expensive service we don't need. This attitude is now changing, partly because people started to realize that, if something happens to the ship due to cyber security issues and they did nothing preventive beforehand, any loss or damage they suffer as a result may not be covered by their insurance," he says. "It is still a gray area, but the insurers have a valid point: this is a foreseeable danger, and if you do nothing to prepare for it, such as taking a look at your basic vulnerabilities and trying to close them, you may be held at fault."



Cyber security is not only about technology security, he points out, but also about ship security, meaning a complete cyber security assessment includes a review of ship-specific cyber policies. If, for example, a technician carrying an ID from a radar company shows up unexpectedly to perform some maintenance, sound practice would recommend a call to verify his identity. The first step to cyber-health, then, is to thoroughly assess all software and cyber-related activities ashore and onboard.

In the digital realm, identifying vulnerabilities, finding key knowledge gaps and rectifying problems is not always a straightforward endeavor – as most people who have had to deal with computer problems know all too well. On the enterprise level, cyber investigation is an extremely complex endeavor that calls not only for general technical expertise and industry-specific experience, but also for the informed intuition that comes from the combination of the two. Zachariadis says maritime companies would be well advised to seek help with their cyber assessments from providers that have expertise in both cyber security and ships.

“I don’t think any company can do a complete cyber assessment on its own – there’s just too much to know. You can find maybe 80 percent of the holes through your own assessment, but to get them all you need outside help,” he says. “We started on this earlier than many other companies because we recognized the danger, but – even though I am very much involved in cyber security issues and our company has this experience – we didn’t fully understand the extent

of our vulnerabilities. We performed an internal assessment, but doing the job onboard a ship with ABS was an eye-opener. We found things we would never have thought about.”

“One unexpected finding involved the shipyard-installed engine room monitoring hardware and software – which allow our superintendents to see the performance of all equipment from their desk computers or laptops in real time – and also allows the shipyard and equipment vendors to diagnose and ‘repair’ problems remotely. This remote ‘repair’ may involve changing operational and alarm settings, etc.,” he explains. “During the assessment we realized how easy it would be for a third party to compromise such operational parameters – it was a matter of a simple password. Another unexpected finding was the tendency of crewmembers to charge their personal devices (smartphones, iPods etc) using any USB port in their vicinity, including those of the main engine control console or navigational instruments. Obviously, any virus in their instruments could wreak havoc in the ship’s critical systems.”

THE HUMAN FACTOR IN CYBER SECURITY

Atlantic Bulk Carriers has completed one shipboard cyber assessment with ABS thus far, and is gearing up to assess the rest of its 20-vessel fleet. One of the biggest holes discovered during that first assessment had to do with crew attitudes – not of disrespect, but of disbelief. It is an element of the issue that has yet to receive due recognition, Zachariadis says, but once recognized it can easily be remedied.

"The main problem is that they haven't really thought about the danger, not because they're negligent. With a little training, the attitudes change quickly," he says. "Many people in our industry still do not believe in the seriousness of the threat. They think that cyber criminals have better targets to go after and the whole thing is a non-issue that 'will never happen here.' It's the same attitude that existed at the management level until fairly recently. Now, with that attitude changing, the industry is approaching the 'Fair' point in cyber awareness, but the crew side of things is still a few years behind. As an industry, we have a lot of training ahead, to change those attitudes."

Fortunately, training philosophies have changed dramatically in the past 10 years and now tend to focus on transmitting understanding rather than on imposing knowledge.

"Training is no longer about the boss saying 'this is what I want you to do and how I want you to do it, end of story.' Now we all know that if you can make people understand an instruction - why it is good for them, for the company and for everybody - they will take ownership of it and follow it," he says.

This is especially important to onboard cyber security for three related reasons. First, modern ships tend to have wired Internet access in every cabin, because that feature helps attract the best crewmembers.

Second, people engage in risky cyber behavior every day, such as using public Wi-Fi to access secure sites and pay bills, visiting dodgy websites when bored, and not running malware scans on drives and devices that connect to hotel equipment. Third, as the past decade of data breach reports makes plain, the cyber safety of a business is directly undermined or bolstered by the personal cyber safety practices of its employees.

Asked for a word of advice to those companies still unconvinced that cybersecurity is their problem too, Zachariadis says, that the issue truly needs to be taken seriously.

"Even if it is not apparent now that cyber security is a big issue, with the speed at which technology is evolving it will soon become a big issue," he says. "We have already had a few high-profile incidents, and I have heard of others that were not reported because they didn't end up in an event that was visible to the world. We must consider that this issue will not go away, but only get worse going forward - it may not be a matter of survival today, but it will be a matter of survival in the future. So, do a cyber assessment and do yourself a favor," he concludes. "In the end, you will have to investigate this issue, whether or not you believe in it, and when you look into it you will be shocked. You will find out that you have many more vulnerabilities than you ever imagined, both ashore and on your ships - but," he adds, "knowing the true parameters of a problem is 50 percent of solving it." ■



A CLEAN-BURNING BULKER FOR THE HIGH SEAS

LOSSLESS DESIGN MAKES LNG POWER PRACTICAL FOR LONG-HAUL BULK CARRIERS

Technology doesn't converge by itself. Only vision, inspiration and hard work can fuse existing technologies into something new and revolutionary. Case in point: Project Forward, a team effort that after three years of intense labor developed a design for what promises to be one of the cleanest, most efficient, environmentally-protective long-haul bulk carriers yet seen.

Formed and led by Athens, Greece-based Arista Shipping, Project Forward gathered together a Round Table of innovation consisting of classification organization ABS, engine maker Wärtsilä, ship designer Deltamarin, containment system builder GTT and energy major Royal Dutch Shell. ABS provided classification and advanced design evaluation services; Wärtsilä brought its DF Series dual-fuel engine technology; Deltamarin offered an 82,000-dwt kamsarmax hull as the starting point of the design spiral; GTT came with its LNG containment system; and Shell signed on to deliver the LNG bunkers globally. Their joint aim was to develop a commercially-viable long-haul LNG-fueled dry bulk carrier capable of complying with the International Maritime Organization's (IMO) Energy Efficiency Design Index (EEDI) 2025 standards and stringent new Marpol

Annex VI limits on the levels of nitrogen oxides (NOx), sulfur oxides (SOx) and particulate matter in marine exhaust emissions.

Because natural gas contains virtually no sulfur and no particulates, it has for decades been hailed as the clean marine fuel of the future – if only it could be built into a workable business model. Project Forward set out to determine if that vision was possible.

They not only concluded that a gas-fueled ship is viable, but also designed a vessel, named the Forward 84, that is expected to emit up to 35 percent less CO₂, 80 percent less NOx, and 99 percent less SOx and particulate matter, than equivalent merchant ships using conventional fuel oils. The keys to their solution were a radical machinery concept, a clever fuel tank and a precision hull refinement – and an elegant design whose simplicity belies the massive effort that went into its creation.

CLEANER FUEL, OR FUEL CLEANER?

“Realizing the potential of natural gas to satisfy all emissions regulations, we saw the fundamental choice facing us, and the industry, as: either produce pollutants and remove them from the exhaust, or don't produce them in the first place,” says Antonis Trakakis, Technical Manager of Arista Shipping.

“It was clear from the start that compliance with the coming regulations was going to cost money, whatever you choose to do, so we decided to perform a thorough investigation of oil vs. LNG as fuel for our bulk carriers. Each has its challenges, so we began the project without prejudice, starting from a blank page and taking a very honest and realistic approach to both,” he explains. “This was the essence of Project Forward: to see things in their real dimensions, so to speak – not setting out to prove one or the other technology was better, but to find the truth and find a way forward.”

On the surface, gas starts out with several strikes against it. First, a ship needs a lot more LNG than oil to go a mile. The difference in specific gravity between the two liquids means that an LNG fuel tank must be about twice the volume of an oil tank to support a given voyage range. In addition, LNG is a cryogenic liquid and needs to be stored in very large insulated



Antonis Trakakis,
Technical Manager,
Arista Shipping



tanks (large enough to have an impact on cargo space), after which it is regasified and burned in advanced dual-fuel engines. Altogether, LNG is rather a diva of fuels – everything about it is special and dealing with it comes at a significant premium.

To absorb those difficulties, Trakakis came up with a highly unusual machinery arrangement that does away with generators, boilers and all emissions treatment systems. The road to this novel solution started with a look at LNG's knotty NOx problem.

NOx is a product of the internal combustion process itself, created from the air in the cylinder chamber by the temperatures and pressures of combustion. Engines emit NOx to varying degrees no matter what fuel is used. That is why many ships using natural gas as fuel also have catalytic NOx removal systems treating their exhaust gases. Trakakis wanted to control the engine's NOx production to eliminate the need for exhaust treatment, but to do so he had to conquer the problem of 'methane slip' – the tendency of gas-fueled diesels to allow a small amount methane

to leave the cylinder unburned, or 'slip out' into the exhaust. If you want to cut greenhouse gas emissions, you certainly don't want methane slip.

ENGINE ROOM REVOLUTION

One traditional technical challenge to using gas as a marine fuel has been an unavoidable trade-off between NOx production and methane slip, a problem that stems from a combination of thermodynamics and engine technology. Engines operate according to one of two thermodynamic cycles, Otto or Diesel. The Otto cycle – which is employed in automobile engines – is the lower-pressure of the two, and by nature generates very low NOx levels; the drawback to Otto engines when fueled by natural gas is that they generate methane slip. Diesel cycle engines, operating at higher temperatures and pressures, burn the entire charge of methane in the cylinder but generate far more NOx. The answer to this persistent problem was drawn from the engine itself.

"We found the latest DF engine, which is much advanced over previous versions, gave us the

possibility to adjust the methane slip,” Trakakis says. “Through careful use of the technology in this new low-pressure system we were able to reduce the slip to very, very low levels, and achieve both objectives at once. And, once we identified the low-pressure system as the one closest to what we need, we developed the concept of two engines doing everything.”

The Forward 84 design calls for two Wärtsilä 31DF medium-speed engines connected through a gearbox to a single shaft driving a controllable-pitch propeller. Two shaft generators provide all the ship's power, allowing the vessel to save money and space by eliminating all generator sets and their associated emissions treatment systems. Further, since the vessel does not burn heavy fuel oil (HFO), it has no need to generate high heats used to make the tar-like HFO flow; this reduced heat requirement means the ship has no need to produce steam, so can also do without boilers. Nor does it need any of the fuel separation and cleaning equipment associated with HFO. The vessel's hot water is produced with heat recovered from the exhaust gases, as usual, and warmth is delivered throughout the ship by an electric heating system.

“In the end, the main engines do everything – they provide propulsion for the ship and all the electric power needed onboard. We used to refer to the engines driving the propeller as prime movers. Now they have a new title: ‘total movers,’” Trakakis says.

This extensive machinery reduction led the Forward team to its most impressive coup of all: gaining cargo capacity, rather than losing it, through use of LNG as fuel. The simplicity of the solution disguises the difficulty of making it work.

“I was determined to not lose any cargo space,” Trakakis recalls. “This is another special feature of our project. We wanted to develop a real, competitive, commercial vessel for global trade, not a ‘demonstration platform’ or a special vessel limited to regional or small-range voyages. So, we looked at Deltamarin’s standard kamsarmax design and asked how much LNG it would need to go 40 days full-speed at sea,” he says.

That figure was not chosen randomly. The team considered the lengths of their longer journeys – like going from China to Europe through the Cape of Good Hope, which takes 32 days – and determined that 40 days worth of fuel would be more than enough for their needs, he explains. With that in mind, they calculated that the ship needed onboard storage capacity for 2,500 m³ of LNG, a volume that would render conventional cylindrical storage tanks impractical in terms of space requirements. They turned to the membrane system because that type of tank can be tailored to a particular space and, after



much experimentation, found they could meet their goal by elongating the vessel slightly and placing a vertical fuel tank between two cargo holds amidships. A beautiful solution, but it came with consequences.

Extending the vessel length introduced frictional losses that reduced the hydrodynamic efficiency of the hull – a big strike against satisfying IMO's 2025 EEDI mandate. To remediate this debit, ABS worked with Deltamarin on extensive hull refinement through computational fluid dynamics, and, ultimately, came up with some extreme optimizations that recovered all the frictional losses. At the end of the day, the machinery reduction, vertical LNG tank and ultra-optimized hull envelope gave the designers opportunity to increase the vessel's cargo capacity, from 82,000 dwt in the base design to 83,500 dwt in the new one.

“The elongation does not hurt our trading capabilities,” Trakakis reports. “We have discussed this with our charterers, and they have no problem with the new length. Our ship can go anywhere a normal kamsarmax can go.”

BONUS PRIZE: SUSTAINABILITY

In tandem with the nuts and bolts of technical development, the team also had to build economic models for each iteration of the design as it evolved, to compare the efficiency and cost-effectiveness of the



new vessel with those of a standard vessel running on liquid fuel. The final big question for Project Forward, as with all innovation, was whether this new idea would be commercially viable.

Key to that assessment was having as good a projection as possible of future LNG price trends, and a sense of security as to the availability of LNG bunkers. Shell provided assurance of that availability. Further, analysis concluded that, over time, the price of LNG would be more stable than that of oil.

"After a lot of calculation, and taking into account future fuel price variations, we found that the vessel would not only deliver very good performance, but would also provide a substantial cost benefit in the order of \$1.35 to \$1.5 million per year," Trakakis says, adding that, on top of it all, the design is fully applicable to both wet and dry cargo vessels and scalable to larger and smaller ship sizes.

"In the end, we developed an LNG-fueled ship that is longer, has greater capacity and is competitive on fuel consumption when compared against standard vessels. Now, what does that really mean?" he continues. "We have reduced costs, reduced emissions and satisfied all regulations in a way that makes transportation less expensive for the



charterer and for the buyer, all in one – in other words, sustainability. We developed not only a new ship, but also a model for sustainable shipping. That is the most important outcome of the project," he says with great satisfaction.

Reflecting on the project and the long journey to its successful conclusion, Trakakis says he takes greatest pride not in any particular element of the design, but in the process that led to its creation.

"The road getting here was a very, very long one," he recalls. "Many things had to be accomplished in those years, and none of it was very straightforward. It took a lot of trial and error to find the best solution. There are many aspects of the design in which we can all take great pride," he says, "but I am most proud of the collaboration, that so many leading international organizations embraced this project and worked together with us to finally remove the barriers to application of this new fuel." ■

GENERATIONS AT WORK



Luxury yachts populate a world in which quality is never a question, and therefore tend to set themselves apart through the merits of design and craftsmanship rather than the details of engine operations. Every so often, however, opportunity and foresight combine to distinguish a

vessel technologically as well as aesthetically. Such is the case with a new 80-meter mega-yacht building on the shores of the Marmara Sea at Bilgin Yachts in Turkey.

Currently designated Bilgin Model 263, and regarded as the company's flagship, the vessel is the world's first yacht to be powered by the new Series 4000 engines from MTU, which received IMO Tier III certification in March this year. The engines feature a compact integrated selective catalytic reduction (SCR) system that reduces NOx emissions to below IMO Tier III levels and particulates to below the EPA Tier-3 limit. According to the manufacturer, the engine can switch between Tier II and Tier III operation as needed and will help ease the space and weight burdens imposed on yacht builders by the typically bulky equipment that NOx regulations require. Twin V-16 engines will power the ABS-classed vessel, which will have a top speed of 18 knots and a voyage range of 5,000 nautical miles, according to the builder.

In the future, Tier III operation will be a standard among yachts, as any vessel with keel laid after 1 January 2016 that fails to meet the mandate will not be allowed to sail the waters of the Caribbean, the Hawaiian Islands or any Emissions Control Area. The Bilgin 263 was not required to comply with the regulation because its keel was laid well before the deadline; it joined the yacht world's environmental vanguard by owner's choice.



Sencer Güneer,
Production Manager,
Bilgin Yachts

Luxury mega-yacht builders work in a highly competitive market that targets a relatively small client base, and thus treasure repeat business – like the buyer of the 263, who previously owned two smaller Bilgin creations and recently ordered a second 80-m vessel, which is now building alongside its sister. The 263 is scheduled for commissioning in 2019, and its sister vessel is due to be launched in 2020. Mainstay customers, such as this, have helped Bilgin achieve rapid growth and international recognition during the past decade.

A symbol of that growth is the company's new headquarters, a shining 14,000-m² shipyard recently completed at the West Istanbul Marina, about a 45-minute drive from the Grand Bazaar in the city center. A center for outfitting and interior finishing, it is one of four shipyards that Bilgin Yachts operates in the greater Istanbul area, the others being its former headquarters in Küçükçekmece and two shipyards in nearby Yalova where large steel hulls and aluminum superstructures are constructed.

Bilgin Yachts grew out of a family boatbuilding tradition that stretches back to a master shipwright named Hüseyn and his sons Bilgin and Mustafa Şengün, who at the beginning of the 20th Century worked the Istanbul boatyards crafting vessels for the Sultan. Mustafa's son Hüseyn opened his own workshop in 1957, and his son Bilgin founded the yacht business a decade later. The company specialized in wooden yachts up to 45 meters long until seven years ago, when it created its first 50-meter mega-yacht using a steel hull and aluminum superstructure. That combination has been the basis of all Bilgin mega-yachts since.

"The main engines and much of the equipment used by luxury yachts is similar – all high-quality, major brands and high-standard products – and many make use of steel hulls and aluminum superstructures," says Sencer Güneer, Production Manager for Bilgin Yachts. "Where you distinguish yourself as a builder is through craftsmanship, production quality and the finish you put on the





product – from the joinery and the materials to the fabrics and interior detailing. Attention to detail makes all the difference in this business.”

The artisan’s touch is a major part of that attention to detail. With that in mind, Bilgin has worked hard to keep much of its manufacturing in-house, using direct employees to perform approximately 90 percent of all construction and finishing work, with the remainder provided by a small group of longtime subcontractors. In its 5,000-m² marine furniture facility, more than 300 talented woodworkers – some of whom have been with the company for decades – use age-old skills to bring the touch of the craftsman’s hand even to futuristic vessels.

The furniture division is organized into departments according to specialty (varnishing, carving and so on) and the work is carried out by teams of masters and apprentices. This keeps a continuity of skills and knowhow flowing between the generations.

“It is very important to keep this knowledge within the company,” Güneer says. “In this way you don’t have to ‘rent’ experience through subcontractors; knowledge and experience stay in the company, improving our skills and abilities over the long term. This is a big

advantage, especially when it comes to woodworking and interiors.”

“The company has grown dramatically in the past ten years,” he adds. “It is a family-owned business, and the present generation of owners takes care to reinvest in it and improve it. The reason for that is very simple: yacht building is not just their core business, it is their only business.” ■





A FLOATING VISION OF PLASTIC-FREE SEAS

With beautiful beaches and an architectural heritage stretching back 600 years, Lamu Island off the coast of Kenya is a popular tourist destination. Continuously inhabited since the late 14th Century, it is home to the oldest and best-preserved Swahili settlement in East Africa, and once was a regional center for the construction of the traditional sailing vessels known as dhows. Its beauty has been marred of late because, like many places swept by ocean currents, Lamu has become a collecting point for seaborne plastic trash.

According to the Plastic Ocean Foundation, some 8 million tons of plastic waste enters the ocean each year. These items first entangle, injure and choke sea creatures, but over time break down into microplastics, particles below 5 mm in size that end up ingested by the smallest creatures and, through them, enter the aquatic food chain. How much plastic and microplastic resides in the oceans – and in the local fish shop – is anybody's guess.

Walking along a waste-strewn beach three years ago, Kenyan native Ben Morison, whose business is arranging safari holidays to Africa, became inspired to fight the profusion of plastic in the marine environment. He got the idea to turn Lamu's beach waste into a fully-functioning dhow, an ancient type of lateen-rigged boat that has great cultural significance in the Middle East and Indian Ocean regions, where it is used locally as a cargo vessel. Morison saw it as a 'living' way to raise awareness about ocean plastic pollution and encourage recycling. The problem was that no one had ever attempted to make one of these large vessels entirely of plastic.

To bring the concept to life, Morison enlisted the aid of master boatwright Ali Skanda, a famed dhow builder whose work has been exhibited in museums around the world, including the National Museum in Washington, DC. In late 2016 Skanda's team undertook the challenge of

adapting traditional wooden boat-building tools and techniques to the strange new material they would use.

True to the dream, their synthetic building material is indeed made of plastic collected from Lamu's shores. In all, the boat will repurpose about 45 tons of waste, the first five of which were gathered from a 5-km stretch of beach in a single afternoon by a team of 50 volunteers in September 2016. Sorted and shredded, the plastics are melted, mixed and molded into rough beams and planks by Regeneration Africa, a regional recycler.

Turning shopping bags, bottles and other discards into a solid, reliable structural beam, 10 meters long, 22 cm wide and 25 cm high would challenge any manufacturer. One of the recycler's main struggles was to produce a consistently strong material without included air bubbles, which render it useless. After much experimentation the company developed a

working process, and a 7-meter prototype vessel has now been built.

Because the molded components are unattractive, Morison came up with a finishing touch for the vessel that brings to the project a bit of the bright, joyful spirit found throughout African textiles and folk art: its hull and deck are sheathed in colorful panels made from the soles of flip-flops, which are among the millions of tons of plastic waste currently in the ocean. So far, about 20,000 reclaimed flip-flop soles have been squared-off, affixed to plastic sheet and turned into FlipFlopi panels. The glue melts the sole pieces together, forming a bond as strong as the sandal itself. A combination of adhesive, battens (made from recycled plastic) and screws attach the panels to the vessel. The panels give the boat its name, FlipFlopi.

The 7-meter prototype is scheduled to undergo sea testing in July on completion of the sailcloth, a tough, colorful fabric spun from recycled plastic. Meanwhile,



the keel of the full-size 20-meter dhow is laid, but construction paused pending the prototype results.

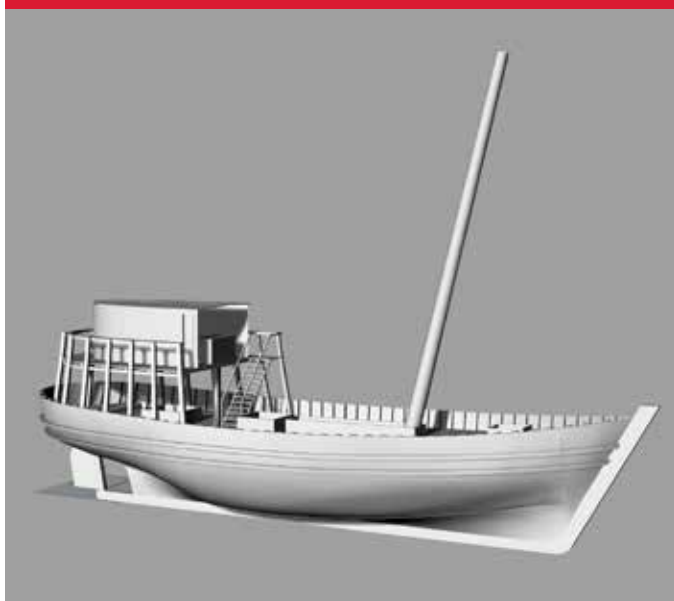
FlipFlopi's ambitious voyage plan is to sail southward for 5,200 km (3,250 miles) along the coasts of Kenya, Tanzania, Mozambique and South Africa, ending at Cape Town. It is a daring dream for at least two reasons: for one, changes in prevailing winds that occur about midway down the coast of Mozambique make particularly challenging work for lateen-rigged boats; then, the vessel must to round the treacherous Cape of Good Hope under sail.

As a dhow depends on a single mainmast, the FlipFlopi team has one big question to answer before any of that can happen.

"Creating the mast is probably our single biggest challenge," Morison says. "A mast requires both strength and flexibility, something very difficult to achieve using plastics, let alone recycled plastics. If we cannot, then this will be made from wood, which could serve as a symbolic link between the old and the new. This is a good example of the whole project: it's never been done before, so we experiment, we test, and eventually find a solution."

No matter how the dream plays out, Morison and the FlipFlopi team hope their work inspires cleanup and prevention of ocean plastic pollution, and helps rid the world of single-use plastics. ■

This inspiring, all-volunteer project could use some technical help. Readers wishing to know more can visit its website: www.theflipflopi.com, or write to info@theflipflopi.com.



HELMEPA - SHINING A LIGHT ON CLEAN SEAS AND BEACHES

HELMEPA is very pleased to acknowledge the efforts of the FlipFlopi dhow building team in highlighting the dangers of plastic waste in our marine environment – and in helping to inspire clean-up and prevention efforts. In complete solidarity with projects across the globe to reduce marine plastic waste, HELMEPA has been focusing on preventing plastic pollution of the coastal and marine environment for nearly forty years.

As a voluntary, not-for-profit and non-governmental organization, founded from within the shipping industry by Greek seafarers and shipowners, HELMEPA is dedicated to promoting public awareness of the marine environment. In 1983 with the support of its members, among them ABS, the association began a concerted campaign to spread the message for Clean Seas and Beaches. Since then, HELMEPA has leveraged beach cleanups as a key information and awareness tool for the prevention of marine litter pollution.

HELMEPA's 2017 International Voluntary Beach Cleanup supported 99 beach and underwater cleanups. These efforts comprised 4,800 volunteers, collecting 6.8 tons of litter (largely plastics), along 60 km of coastline. We are proud of our education outreach and our contribution to global research efforts to prevent marine pollution.

ADVANCING MARINE TECHNOLOGY ON THE BRINK OF THE FOURTH INDUSTRIAL REVOLUTION

Humankind stands at the edge of a technological revolution that will deeply alter the way we live, work and relate to one another. In its scale, scope, and complexity, the transformations of the Fourth Industrial Revolution will be unlike any before experienced. How it will transpire is not entirely known; however, we do know our response must be integrated and comprehensive.

Today's transformations are distinctly different from previous ones in terms of velocity, scope, and systems impact. The speed of current breakthroughs is disrupting every industry, and the maritime industry is no different. Having finally resolved the vast majority of structural issues that confounded designers, engineers and builders for virtually the entire history of ships and shipping; we have begun focusing on digital technologies, on how they can improve the things we do and the things we build.

Our challenges in this era will be in resolving increasingly complex issues – in which significant

progress will most likely come not through the efforts of individual organizations – but through cooperative research and development projects. Uniting and focusing diverse expertise, will allow us to quantify difficult problems and develop innovative solutions. These difficult problems are not related to technology or systems only, but more importantly, how people use technology to make our industry and their jobs better – whether onboard crew or ship owner.

ABS' current joint research projects with the Greek shipping community illustrate this very well. They continue our legacy of working with Greek shipowners to push the boundaries of technology, a history that can be traced back exactly 60 years to the moment in 1958 when the supertanker race pushed vessel sizes beyond the perceived 100,000-dwt "limit" – raising widespread concern about the behavior of large structures at sea. The unity of purpose between industry, academia and Government in resolving the great issues of the past stands as a model for all our groundbreaking work now and going forward. Many of our current projects stem from increasingly complex technologies and requirements. Although some address topics undreamt of in the past, all proceed with the same spirit of cooperation and the same drive for practical results.

On that matter, consider cyber security assessments. Not long ago, all but a relatively small number of people in the maritime industry thought cyber risk was a non-issue. But a small group of early adopters, working with ABS to understand and resolve their own issues, helped expose the cyber vulnerabilities of an entire industry and helped ABS formulate a process of diagnosis and resolution from which all maritime companies can benefit.

Another instance of conjoined expertise pushing boundaries and achieving remarkable effects can be seen in Project Forward. It was far more than just another LNG-as-fuel exercise, because it developed a long-haul bulk carrier that claims to satisfy all emissions regulations without any fuel cleaning or exhaust gas treatment equipment – a concept that can be widely applied to several ship types. Computational fluid dynamics made that hull efficient and viable.



Christopher J. Wiernicki,
Chairman, President and CEO, ABS



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In this new era, advanced analyses and digital technologies will play an increasingly critical role in bringing about technical progress, both through better use of mature systems and cultivation of new concepts.

Thus, in the “smart bearing” study, we are working with shipowners to develop a novel system for monitoring and analyzing bearing loads, and misalignment angles, using strain gauges installed in specific locations on the bearing housing. In another project, data analytics are helping evaluate how digital and smart machinery data collection can be leveraged in condition-based classification and survey programs to reduce the impact of inspection on marine assets, allowing an alternative to the calendar-based survey approach.

Techno-economic studies are another area in which digital abilities bring greater accuracy and confidence to predictive analyses. In one of these projects, we are using data analytics to reduce several possibilities into practical decision assistance for owners grappling with the choice between committing to low-sulfur fuel or to fuel sulfur reduction equipment (SOx scrubbers). In another, they help evaluate the range of sulfur cap compliance solutions for selected vessel designs intended for operation inside and outside ECAs starting in 2020, through analysis of main propulsion plants and auxiliaries operating on conventional residual and distillate fuel oils.

These are just a few examples of the joint development projects that characterize the dawning of the Fourth Industrial era, in which digital technologies can rapidly close the gap between theory and practice, between concept and reality, between the possible

and the viable, and between tomorrow and today. It is important to recognize that in these efforts, we can never underestimate the importance of people. It is the ideas, the imagination and the diligence of people working together that power the key breakthroughs in our industry and our world. ■



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